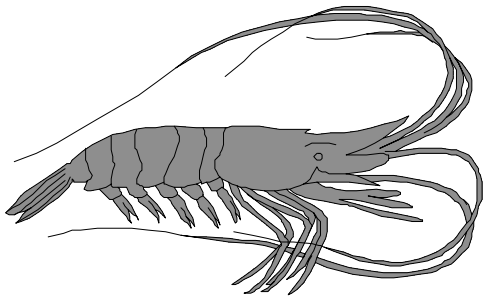
Major Species

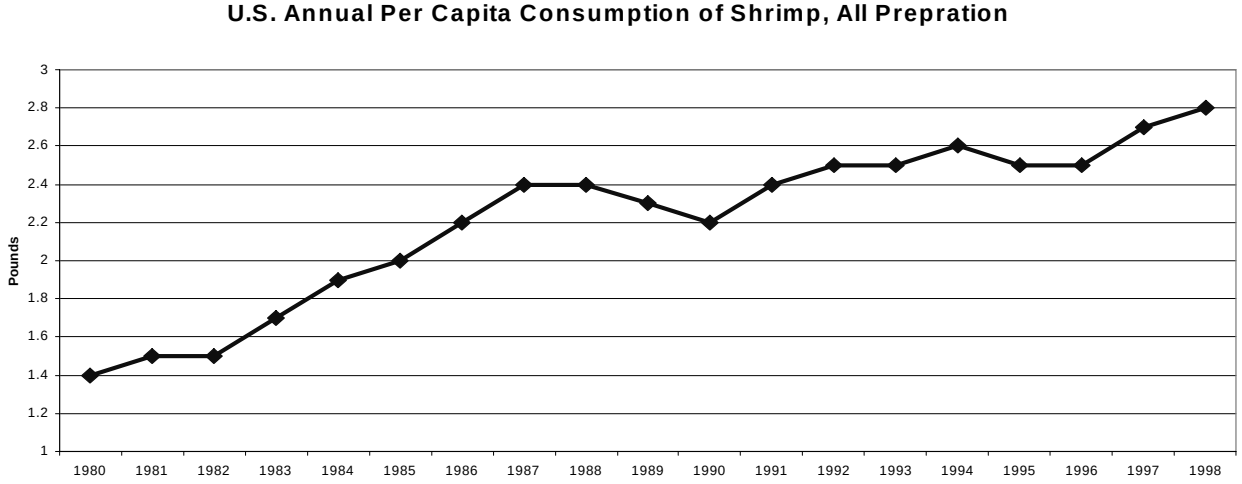


Freshwater Prawns

The freshwater shrimp, or more properly freshwater prawn, is a member of a large group of freshwater crustaceans found in many parts of the world. There are several species found native to the U.S., but most aquaculture efforts have concentrated on the Giant Malaysian Prawn (*Macrobrachium rosenbergii*) which is a native of southern Asia. Culture efforts in the U.S. were initiated in Hawaii in 1960s, South Carolina in the 1970s, and Mississippi in the 1980s. Despite these efforts, substantial concentrated production of this species has not developed. Large scale production has been hindered by relatively low production rates, size variability at harvest, and a relatively demanding process for producing seedstock.

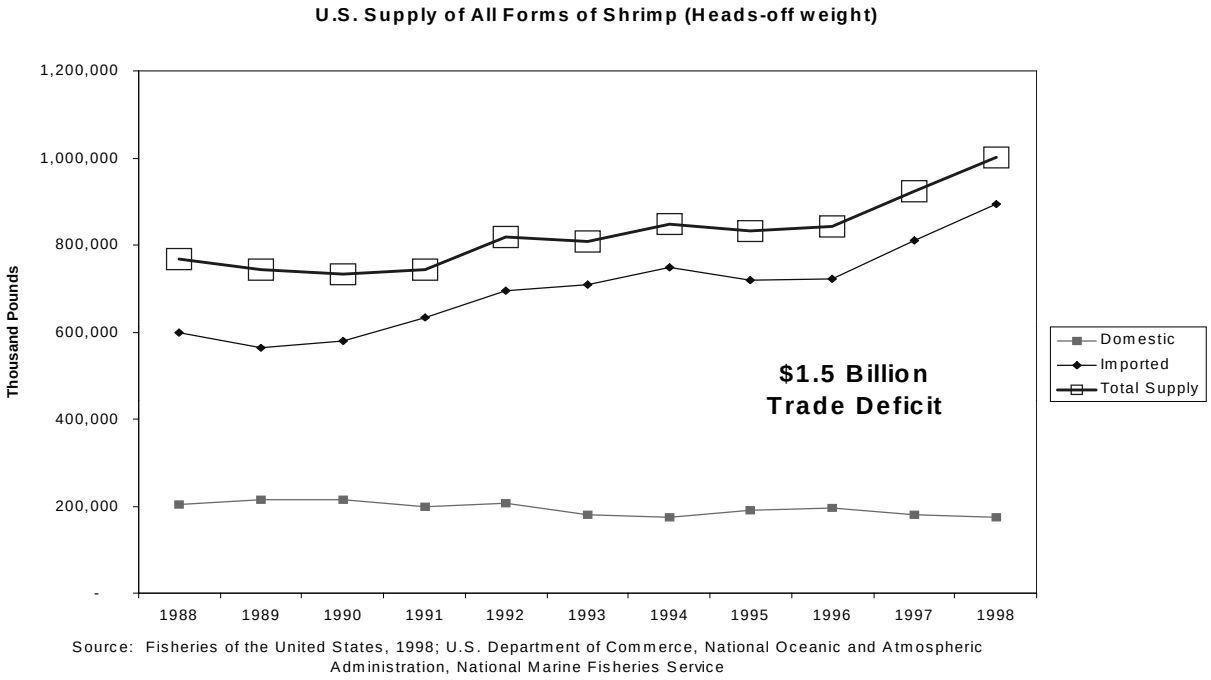
Over the past five years interest in production of this animal has again increased due to an increasing demand for shrimp products, reduced supplies of shrimp (especially large sizes) due to serious disease problems in saltwater shrimp production, and increases in production rates for prawns based on new management and production practices. Other factors producing increased interest in production include identified markets for live and fresh prawns in inland locations, the growing trend among consumers wanting to know of how their food was produced, and the discovery that prawns actually grow more rapidly at cooler temperatures.

Chart 6 – U.S. shrimp consumption has steadily increased over the last 18 years.



Source: Fisheries of the United States, 1998; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Chart 7 – U.S. domestic supply of shrimp has remained steady while imports have increased to meets needs of increased consumption of shrimp.



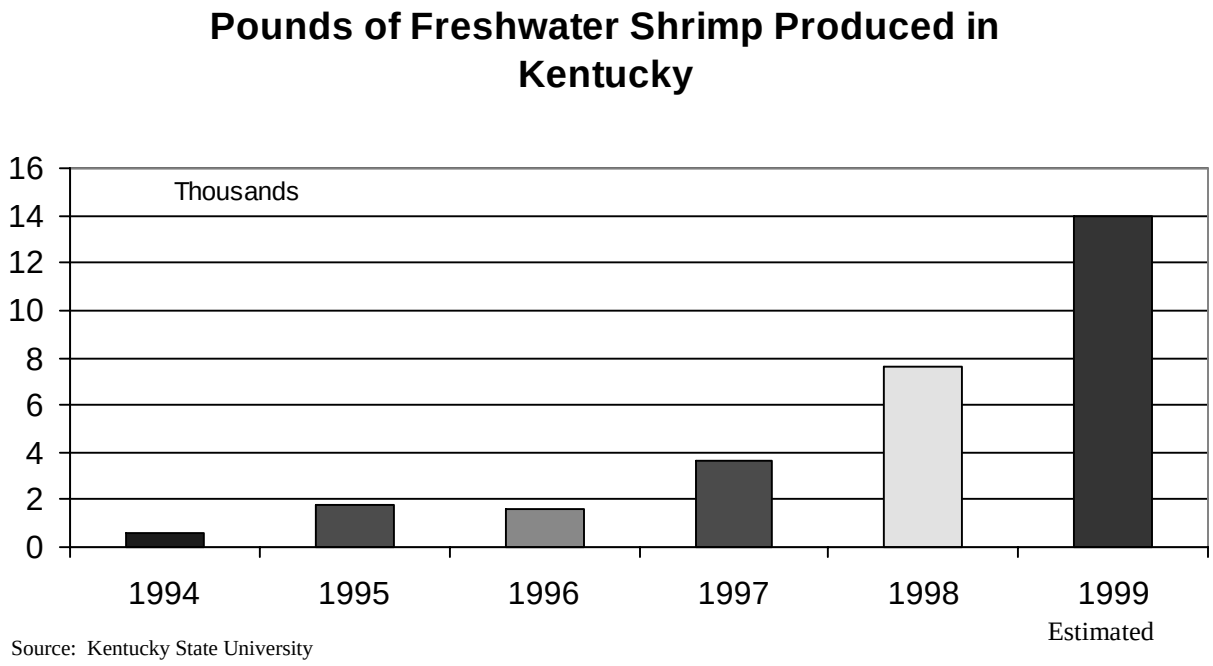
Source: Fisheries of the United States, 1998; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Seedstock production for prawns normally begins with selection of broodstock at the harvest of production ponds in the fall. The number of females is based on anticipated production needs. Broods must be overwintered in tanks at greater than or equal to 70º. Volume and added substrate in holding tanks should allow each brooder approximately two square feet of surface area. Broods should be fed a high quality marine shrimp diet or sinking salmonid pellet. Either should be supplemented with fish flesh and beef liver so that the females can store the proper nutrients in the egg yolks for the larvae to live on after hatching.

In Kentucky, production ponds are stocked in late May-early June with what are known as 60 day nursed juveniles (0.3-0.5 gram average weight). That is they have been grown for 60 days in freshwater after completing 30 days of larval development in brackish (salty) water. This means prawns should be hatched from mid-February to mid-March to allow sufficient nursery time prior to pond stocking.

Nursery tanks are normally much larger than larval tanks as stocking rates are reduced from approximately 200 per gallon in the larval tanks to 20 per gallon in the nursery tanks. These tanks must also be provided with mesh substrate structures sufficient to produce 40 post larvae per square foot density. In the nursery phase, water temperatures are maintained at 78-82ºF and the prawns are fed trout starter feeds at a declining percentage of body weight.

Chart 8 – Freshwater shrimp production has increases in Kentucky.



Source: Kentucky State University

Production ponds should be properly prepared before juvenile prawns are transferred from the nursery. Most ponds used are 0.5-1.0 acre in size. Proper dimensions are for the pond to be about twice as long as it is wide. The pond bottom should slope to the drain end where a 8-10 inches drain pipe is located in the bottom of a catch basin which runs the width of the pond bottom. This catch basin is 1.5-2.0 feet deeper than the adjoining pond bottom and about 8 feet wide. Ponds are equipped with either paddlewheel or turbo aspirator type aerators which also mix and destratify the pond. Aerators are placed at the center of one of the long levees about six feet out in the water and push water straight toward the center of the opposite levee. Approximately 0.5-1.0 hp of aerator capacity is needed per acre. If ponds have been filled more than two weeks they should be treated to reduce predaceous insects.

Juvenile prawns can be transferred to the ponds in plastic bags filled with oxygen. These bags are floated in the pond 20-30 minutes before opening to allow temperature adjustment. The bags should be transferred in early evening, or protected from the sun if moved during the day. After 20-30 minutes the bags may be opened and pond water added at about a quart every 5 minutes. This will allow the juveniles to adjust to the factors other than temperature (i.e. pH, hardness, etc.). The number of prawns to be stocked depends primarily on marketing considerations. The higher the stocking density the greater the production (pounds per acre) but the smaller the average prawn. The other factor affecting stocking density is whether artificial substrate is added to the pond. To produce very large prawns, stocking densities of 8,000 - 12,000 per acre will produce about 600-700 pounds per acre with an average weight of 40-45 grams (10 prawns per pound). At 16,000 prawns per acre without substrate, about 1,000 pounds per acre of prawns are produced averaging 30-35 grams (12-15 prawns per pound). With artificial substrate added, the density can be increased to 24,000-26,000 per acre with production of

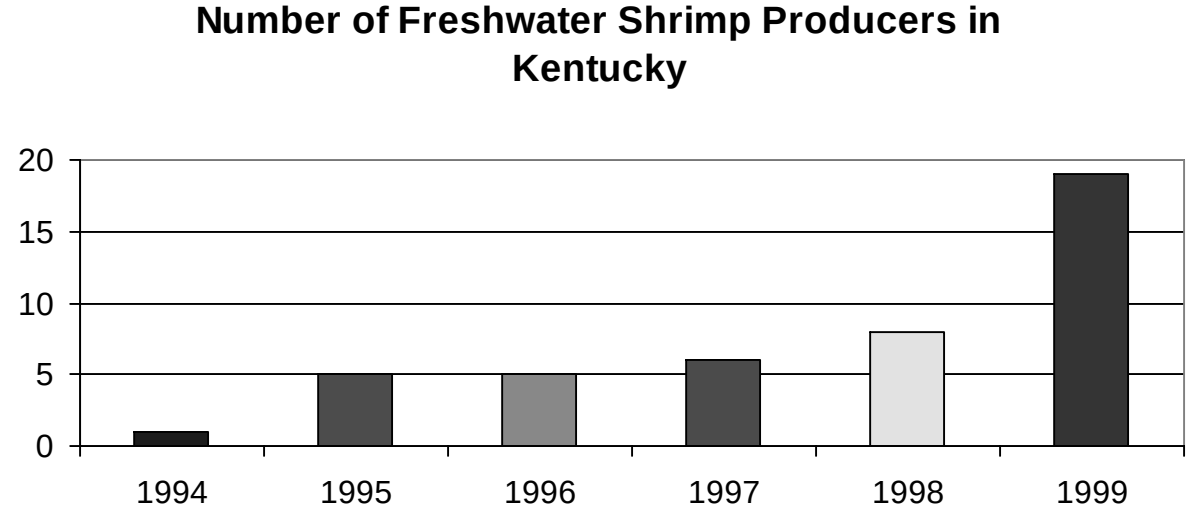
1,500-1,700 pounds per acre at this same average size of 35 grams.

Feeding of prawns should begin within 1-2 days of stocking. For the first month, supplemental feeds such as distillery by-products can be used at 20 pounds per acre per day. During month two, a 32% protein commercial pellet is gradually mixed in with the distiller's grains. During months three and four, a 'high' quality freshwater or marine shrimp pellet is fed based on body weight. From stocking until prawns weigh 5 grams, feed at 25 pounds per acre per day, distributing half in the morning and half in the evening. After prawns reach 5 grams in average size, the feeding rate is based on a percentage of the total estimated weight of prawns in the pond. During the period prawns are 5-15 grams, they are fed 7% of their weight daily, 15-25 grams are fed 5% of prawn weight, and greater than 25 grams are fed 3% of total prawn weight. Survival is assumed to be 100 percent.

To harvest the prawns, the pond is drained down to concentrate prawns in the harvest basin. Adding freshwater or providing aeration in the catch basin during harvest will reduce stress. Prawns are removed from the basin using a small seine then transferred to clean, aerated water (purging tanks) to allow them to remove mud and debris. If prawns are to be marketed live, they can be held in tanks for transport or sold directly to consumers on-farm. Prices of $6.00-$9.00 per pound have been the going prices in-state. If prawns are to be sold on ice or processed, they should be removed from purging tanks and immersed in ice water for 15-30 minutes to rapidly chill the prawns. They can then be held on drained ice until processed or sold. Maximum holding time is approximately five days for whole (head-on) prawns and 8-10 days for tails.

Presently, the only commercial freshwater shrimp hatchery/nursery is in Texas. KSU has purchased post-larval shrimp from this source and nursed them to stocker size for research and on farm demonstrations since 1994. Since beginning research on freshwater shrimp in 1990, KSU has been able to increase yields per acre, define appropriate production techniques, and demonstrate freshwater shrimp production in Kentucky can be viable.

Chart 9 – More producers are raising freshwater shrimp in Kentucky.



Source: Kentucky State University

Beginning in 1998, the KSU Aquaculture Research Center has been able to hatch and nurse freshwater shrimp from breeder stock. This is an important milestone towards developing an in-state freshwater shrimp industry. Another promising development is the addition of substrate into ponds to provide additional habitat for the shrimp. This technique has shown substantial increases in yield. The KDA has provided a grant to KSU for the 1999 and 2000 production season to provide a secure supply of juvenile shrimp for Kentucky producers to stock into grow-out ponds and to provide technical assistance to private producers to start commercial freshwater prawn hatchery nurseries.

(See appendix for recommended publications on Freshwater Prawns)

Freshwater Shrimp

Gross Revenue

	Yield		Selling Price		**Gross Revenue**	*Your Farm*
	1000	pounds	$6.75	lb	**$6,750**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	16000	prawns	$0.10	1600		
Feed	40	50# bags	$14.50	580		
Hired labor	32	hours	$8.00	256		
Marketing Charge				$405		
Other Operating Costs				486		
Total Variable Costs					**$3,327**	
Interest on Variable Cost		6 months @ 10%			**$146**	
Return Over Variable Costs					**$3,277**	

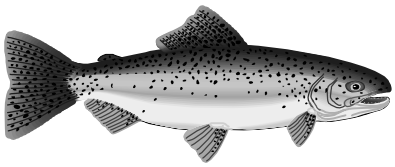
Fixed Costs	**Total Per Acre**	**Annualized**		
Short Term - 5yrs	$355	$71		
Long Term - 10 yrs	$7,210	$721		
Total Fixed Costs			**$792**	
Return to Land, Capital & Management			**$2,485**	
Operator Labor	43 hours	$8.00	$344	
Return to Land & Capital			**$2,141**	

Notes:
Based on per acre production

Additional References

Woods, Timothy, James Murdock, and Seth Riggins, Freshwater Shrimp Enterprise Cost and Return Estimates for Kentucky, Dept Ag Econ, UK, Ag Econ Extension Publication 98-05, December 1998

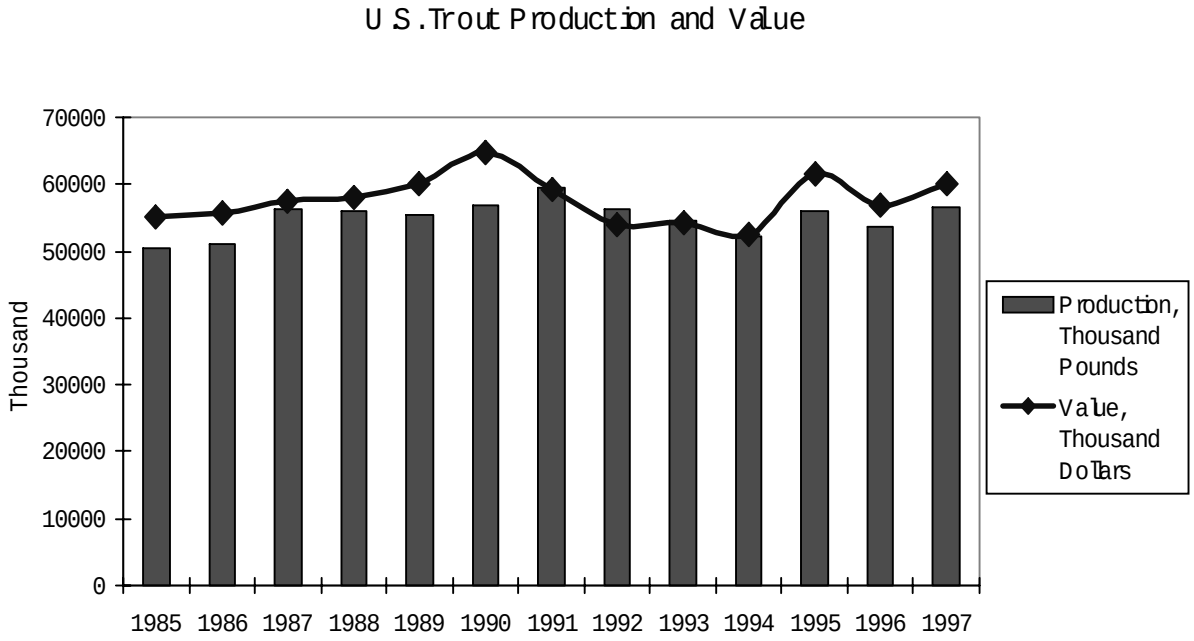
Montanez, J.L., James Dillard, and Marty Fuller, Economic Analysis of Production of Freshwater Shrimp, Mississippi State Experiment Station Bulletin 985, October 1992



Trout

Rainbow trout (*Onchorynchus mykiss*) are native to western North America and have been cultured for over 100 years. Over the last several years, the U.S. trout industry has been relatively stable in numbers of operations and value of sales and output. The state of Idaho produces the most trout in the United States (41 million pounds sold in 1998). North Carolina leads trout production (3.5 million pounds sold in 1998) in the southeastern states. Kentucky has a small, but well established commercial rainbow trout industry with seven year-round farms producing approximately 400,000 pounds. The U.S. Fish and Wildlife, Wolfe Creek National Fish Hatchery, located near Jamestown, Kentucky, also annually produces about 1 million trout for stocking as sportfish.

Chart 10 – Trout production in U.S. has been relatively steady over the last 12 years.



Source: Fisheries of the United States, 1998; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Kentucky trout production is limited by the availability of large freshwater springs which provide gravity-fed water in adequate quantity. These springs must have a year round supply of contaminant free water. To insure trout survival, water temperature should rarely exceed 70 degrees F. For a small trout

facility to provide supplemental income, flow rates of approximately 350-500 gallons per minute would be required. Small scale, full time trout farming would require flow rates of 1,000-2,000 gallons per minute.

Most Kentucky trout farms are equipped with egg incubation facilities. Eyed eggs are typically purchased from commercial brood fish farms located in the western United States. Trout and trout eggs should be certified to be free of diseases. Commercial culture occurs primarily in concrete raceways. Large volumes of water flow via gravity through a series of 4-8 raceways and is discharged into a receiving stream. Densely stocked fish are supplied with cold water which is rich in dissolved oxygen. The water flow removes wastes from the culture unit and is replenished with oxygen when spilled into the next raceway. The water flow rate, water chemistry, temperature, size of fish, and the rate of feeding determines the volume of fish that can be produced in a particular raceway system. Average values are 20-40 pounds of fish per gallon per minute flow rate per year.

Trout may also be stocked in ponds during late fall (October or November) at a rate of 1000-1200 fish per acre in ponds which allow seining and do not contain largemouth bass. During the winter, trout may also be grown in suspended cages and net pens. Trout, 8-10 inches in length are stocked in ponds, cages or net pens, in order to reach marketable size by spring (March or April). Six fish may be stocked per cubic foot of volume of a cage or net pen.

Currently, production and marketing research is underway to investigate profitable alternative water sources for growing trout. These would include waters associated with coal mining operations in eastern Kentucky. South Eastern Community College in Cumberland, Kentucky has been developing a trout production demonstration site as a result of a KDA Value-added Grant. S. E. Community College estimates there may be as many as 500 suitable trout production sites in Harlan, Bell, and Letcher Counties using water from abandoned deep coal mines. Grow-out culture and test marketing of winter, pond-raised trout is currently being conducted in fallow freshwater shrimp ponds. However, the high cost of stocker trout, feed, and poorly developed markets contribute to uncertain profitability of seasonal trout production. Efforts are underway to provide lower cost, advanced trout fingerlings for winter stocking. The KAA has applied for and been awarded a KDA Value-added Grant to contract with a trout producer to supply a lower cost source of Kentucky raised fingerlings. Cooperative purchase of larger feed shipments will be organized to reduce costs. Test marketing of small volumes of fresh trout is being conducted.

(See appendix for recommended publications on Trout

Trout Production in Concrete Raceways

Gross Revenue

	Yield		Selling Price		**Gross Reven**	*Your Farm*
	6250	pounds	$1.25	lb	**$7,813**	
Your Farm						

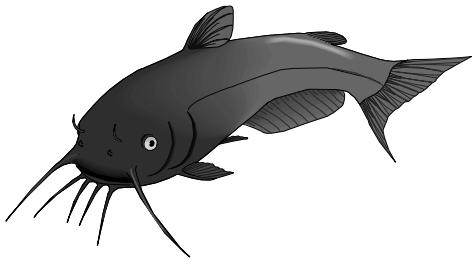
Variable Operating Costs

	Units	Type	Cost per U	Cost		
Stocking Costs	9412	fish	$0.15	1411.8		
Feed - standard	106.3	cwt.	$23.00	2444.9		
Feed - medicated	11.8	cwt.	$34.00	401.2		
Electricity	12		$11.25	135		
Marketing charge	7500		$0.06	450		
Chemicals				37		
Total Variable Costs					**$4,880**	
Interest on Variable Cost		6 months @ 10%			**$316**	
Return Over Variable Costs					**$2,617**	

Fixed Costs	**Total**	**Annualized**		
(2) Concrete Raceways 35' X 6"	$4,494	$300		
Total Fixed Costs			**$300**	
Return to Land, Capital & Management			**$2,317**	
Operator Labor	165 hours	$8.00	$1,320	
Return to Land & Capital			**$997**	

Notes:

SRAC No. 221, Budgets for Trout Production: Estimated Costs and Returns for Trout Farming in the South, 1990 J.M. Hinshaw, E. Rogers, J.M. Easley.



Catfish

There are presently approximately 50 commercial catfish farms in Kentucky according to a survey done in 1998. The main growth area of catfish farming is in the Purchase Area of the commonwealth. Over a million dollars in total catfish sales by Kentucky catfish farmers were recorded in 1998. In Kentucky, catfish farming almost always involves the culture of channel catfish (*Ictalurus punctatus*).

Catfish spawn in late spring/early summer. Since catfish spawn 3-6 weeks later in Kentucky the transportation of eggs from hatcheries in states further south can functionally increase the growing season and produce larger fingerlings by the end of summer. It takes about 5 to 8 days for hatching and another 4 days for the fry to use up their yolk sac energy supply. The fry become swim-up fry and are fed in tanks approximately every 2 hours for about a week. They are then stocked into fertilized nursery ponds that have an abundant natural food source. (Fry can also be stocked into nursery ponds immediately after becoming swim-up fry). In the pond, the fry are also fed a finely ground, high protein feed such as salmon starter. Fry mature into fingerlings and reach approximately six to nine inches in length by the end of the first growing season when they are stocked at 40,000 per acre. Catfish fingerlings are grown in Kentucky but are often hauled in from other states farther south and stocked into Kentucky ponds.

Catfish fingerlings can be sold to commercial fish growers or to recreational pond owners directly or by way of live haulers. Good business is generated by catfish fingerling producers who haul fingerlings to recreational pond owners. In exchange for hauling small loads to the pond owner and providing technical advice, the hauler can charge more for the fingerlings, thus maximizing his or her profit.

Fingerlings of 6-9 inches are stocked into grow-out ponds at approximately 3,000 per acre if aeration is available; or 1,000 per acre without aeration. Stocking of grow-out ponds can be in the fall of the fingerling year or spring of the grow-out year. The catfish will gain more weight during the fall months when they are stocked at the lower density. In addition, they will be in the pond and ready to start growing at the first sign of warm weather the following spring. Often times growers' plans to stock in April are delayed until they can find an available source of fingerlings. This frequently delays stocking until May, and the valuable early-season growth opportunity is lost.

In grow-out ponds the catfish are fed a 28% to 32% protein feed containing soybean, corn, wheat, vitamin and mineral supplements, and usually fish meal. After they are fed, all the feed will be eaten within 20 minutes. This is approximately 1% to 3% of their body weight depending on water temperature

and the size of the fish. Ponds ranging in size from a fraction of an acre to 20 acres or larger are used to grow out catfish. Recent trends in large catfish producing regions in the southeastern United States are for 10 to 15 acre ponds to be used to maximize management efficiency as well as being economical in pond construction costs. Ponds in Kentucky are typically smaller than this; there is a trend for the construction of ponds approximately 5 acres in size in the Purchase region of the commonwealth. Ponds in less flat regions are usually significantly smaller than 5 acres.

Water quality in commercial catfish production ponds must be monitored for water quality to ensure that the fish not only stay healthy, but are able to grow most efficiently. Water quality test kits are recommended for use by fish farmers. Workshops are held by the Cooperative Extension System to teach the proper use of these kits. Ammonia should be monitored at least once a week and nitrite should be checked about 2 to 3 times a week. High nitrite can be neutralized by adding salt (NaCl) to the pond water, and it is highly recommended that catfish farmers maintain a prophylactic level of salt in their ponds in case nitrite concentrations rise unexpectedly. In some parts of the commonwealth, large quantities of agricultural limestone are needed to add hardness and alkalinity (buffering capacity) to the water. This helps to prevent drastic pH fluctuations, which can be stressful to the fish.

In the event that the catfish should get sick during the production phase, there is a fish disease diagnostic laboratory on the main campus at KSU in Frankfort. Accurate diagnoses can be made there as well as appropriate treatment recommendations such as feeding medicated feed or improving water quality. The university laboratory is serviced by an American Fisheries Society Certified Fish Pathologist.

When channel catfish reach market size (about 1.25 pounds) at the end of the second growing season, they can be sold to processing plants or pay lakes either directly or via live haulers. Pay lakes may request that the fish be larger than one pound. About 2 million pounds of catfish are stocked into Kentucky pay lakes each year. Most of this comes from out-of-state sources, but progress has been made during joint KDA-KSU marketing workshops in coordinating business agreements among fish growers, live haulers, and pay lake owners. Other funding from the KDA has helped to establish a harvesting/hauling service for growers needing to have their fish harvested and sold to markets such as pay lakes.

Catfish are typically harvested with polyethylene or coated nylon seine nets that have floats on the top and heavy weights on the bottom. Seines can be pulled by hand by a harvesting crew or can be moved with tractors driving on top of the pond levees. Live cars (or "socks") of a specified net mesh size can be attached to some seines, and are used to grade the fish in order to retain only the fish large enough for marketing and allow the small fish to escape back into the pond. After the fish are graded, they are dipped out of the live car and weighed before selling to the buyer. This can be done by hand or with the use of a boom and harvesting basket attached to an in-line scale.

Marketing to processing plants is an option for Kentucky catfish farmers. Presently, the only plants available are out-of-state. Kentucky-based fish processing plants operated from the late 1980s to the mid-1990s, but are currently out of business. Now, through a KDA value-added grant, a cooperatively owned processing plant is being organized in western Kentucky.

Expansion of Catfish Production

The KAA and the Purchase Area Aquaculture Cooperative are examples of producers that are organizing to develop catfish production, processing, and marketing. There is a great deal of technical support available to further development the industry, including the KSU Aquaculture Research Center, Cooperative Extension Specialists, and the KDA.

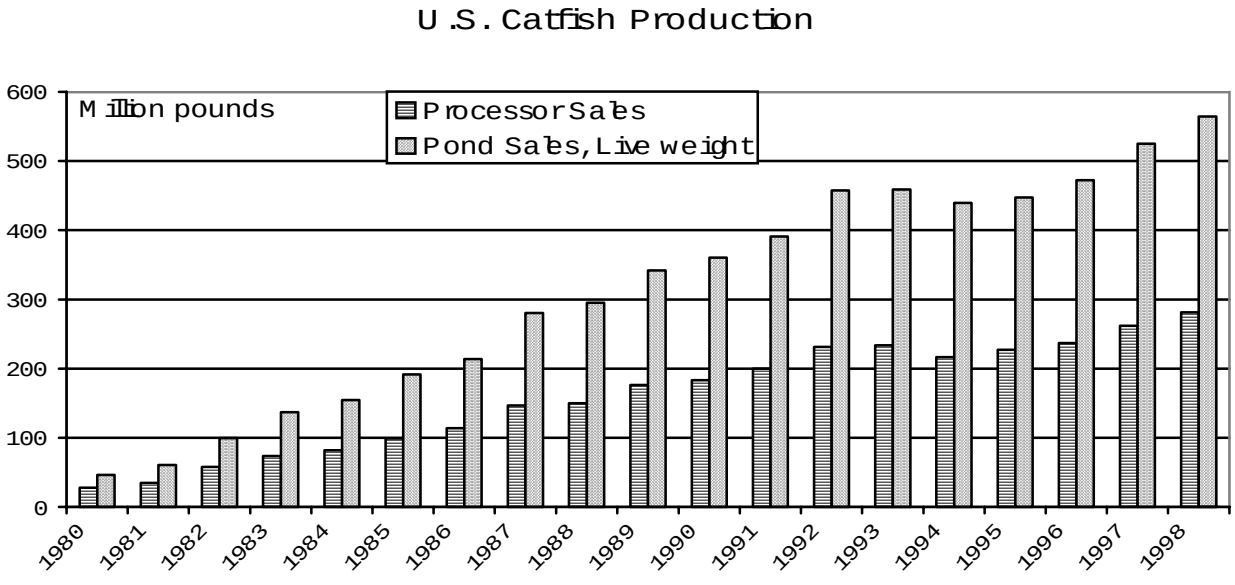
The natural resource base for expanding catfish production in Western Kentucky is excellent for several reasons:

a) There is over 20,000 acres of fairly level (less than 2% slope), poorly drained soils in the purchase area that are better suited for building level type catfish ponds than they are for their present use, row crop production.
b) Western Kentucky has an abundant supply of good quality groundwater at relatively shallow depths. This water supply is essential for good management of catfish ponds.
c) The growing season is adequate to produce 1¼ to 1½ pound fish, ideal for processing. There are fewer days in which water reaches temperatures high enough to severely stress the fish than in states where the growing season is longer.

Markets for processed catfish are expanding nationally and local markets are excellent.

(See appendix for recommended publications on Catfish production)

Chart 11 – Catfish production, pond side and processor sales, has increased.



Source: USDA

Catfish

Gross Revenue

	Yield		Selling Price		**Gross Revenue**	*Your Farm*
	4000	pounds	$0.80	lb	**$3,200**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	3500	fingerlings	$0.15	$525		
Feed	3	ton	$225.00	$912		
Hired labor - productior	10	hours	$8.00	$80		
Electricity				$375		
Hired labor - harvest	4000	per pound	0.04	$160		
Marekting Costs				$192		
Total Variable Costs					**$2,244**	
Interest on Variable Cost		1 year @ 10%			**$224**	
Return Over Variable Costs					**$732**	

Fixed Costs	**Total Per Acre**	**Annualized**	
Levee Construction	$2,500	$166.67	
Well Construction	$500	$33.33	
Piping	$150	$10.00	
Pick-up Truck	$225	$15.00	
Bulk Feed Storage	$200	$13.33	
Aeration	$200	$13.33	
Feeders	$100	$6.67	
Total Fixed Costs			**$258**
Return to Land, Capital & Management			**$473**
Operator Labor	50 hours	$8.00	$400
Return to Land & Capital			**$73**

Notes:

Based on per acre production

Live-haul to paylakes also presents an attractive opportunity for some producers. This budget is based on marketing to a processor.

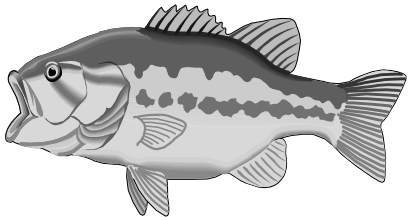
Published yields vary considerably; 3,000-4,500 pounds per acre. Higher yields are accessed through constant aeration.

Production Cost References

Stone, Nathan, Small Scale Catfish Production: Introduction, U Arkkansas CES FactSheet, 1994

Stone, Nathan, Carole Engle, and Robert Rhode, Costs of Small-Scale Catfish Production, U Arkansas CES FactSheet, 1997

Personal interview with Norm Penner



Largemouth Bass

The largemouth bass (*Micropterus salmoides*) is a member of the Sunfish Family (*Centrarchidae*). Members of the genus *(Micropterus)* are known as black bass and share the sunfish family with the bream (*Lepomis spp.*), crappies (*Pomoxis spp.*) and several other genera. The largemouth bass is native to the midwestern and southeastern United States and northeastern Mexico. At present, largemouth bass have been introduced throughout the United States and many other countries worldwide. Interest in the commercial culture of largemouth bass is due to the great demand and a high selling price compared to other cultured species.

The largemouth bass is one of the most popular sport fish in the United States. Although there has been extensive research on largemouth bass for many years, this work has almost exclusively addressed hatchery production and fisheries management. Amazingly little research has been conducted on growth of bass to larger sizes, their nutritional requirements, or suitability as an aquaculture species.

In the 1960s, Dr. Snow at Auburn University conducted a series of studies on raising largemouth to sizes of 6-8 inches on feed as a method of increasing and intensifying hatchery production for sportfish stocking. During the 1980s a number of federal and state hatcheries refined feed training techniques, again to maximize hatchery production. In recent years aquaculturist have become interested in the culture of feed trained largemouth to larger sizes. This interest is based on an increasing demand for large bass for remedial stocking in sportfish ponds, their use in commercial "trophy" lakes, and a demand for live bass as a food fish among ethnic Asians.

The production of largemouth bass fry follows well establish procedures dating back to the 1930s. Largemouth bass are usually pond spawned and do not require hormone or photoperiod manipulations. Broodfish of greater than or equal to 2 years of age and 1.5 pounds in weight are stocked into 0.5-1 acre spawning ponds at 50 brood pair per acre. Ponds must be free of existing fish. Spawning ponds are normally not fertilized so that spawning behavior, eggs, and fry can be observed easily and more easily harvested. Broods may be stocked when temperatures reach 65°F and spawning should begin soon after.

Since spawning ponds are not fertilized a nursery pond should be prepared as soon as spawning begins using organic and inorganic fertilization so as to contain large numbers of food items (zooplankton)

for the bass fry. When large numbers of fry can be seen in the spawning pond, fry should be transferred from the spawning to the nursery pond and stocked at 40,000 - 80,000 fry per acre. After 3-4 weeks in a properly prepared nursery pond bass should reach 1.5-2.0 inches in length and be ready for feed training.

To feed train largemouth bass (and several other species) the basic concept is to remove the fish from the natural source of food, crowd them at high densities, and present them with highly palatable prepared foods at frequent and regular intervals. For feed training, fingerlings (1.5-2.0 inch) are seined from the nursery pond, graded to uniform sizes, and stocked in flow through tanks (round or rectangular) at a high density, which is based on water flow. Fish are then offered either freeze dried krill, ground fish flesh, or fish eggs. Freeze dried krill is especially effective, commercially available, and easy to feed and store. These highly palatable products are then gradually mixed in with a high quality salmonid diet. With fish flesh and eggs a semi-moist diet is produced. Over a series of about a week, each day's feed ration should be increasingly comprised of the manufactured feed. By Day 7 the fish should be consuming straight feed. Fish that have trained to take the feed will by this time be thick bodied, with large bellies, and can be removed with graders. The "feed trained" fish should be moved to a separate tank or compartment and maintained on feed for several more days before pond stocking. Fish that haven't obviously trained can be left in the tank and the use of moist training diets or krill may be repeated. After an additional week most of these fish should adapt to the diet. With good results about 80-90% of the fish originally stocked should train to accept artificial diets. Recent studies have shown that offspring from second or third generation feed-trained fish train easier than those from forage fed fish indicating improvements from domestication.

During the training period tanks should be cleaned daily and water quality maintained by suitable flow through. Because of the crowded conditions and large amounts of feed used, external parasites can be a real problem as can Columnaris. Diagnose and treat affected fish quickly and properly. Terramycin has been used effectively to treat Columnaris by inclusion in the feed training diets. A 0.5 or 1.0% salt bath for up to 1 hour is effective in reducing stress when handling and grading and also will reduce the occurrence of infectious disease. Potassium permagenate has been used with mixed results.

After the fish have been feeding actively in tanks for at least 2 weeks, fish can be stocked into ponds at 20,000 - 30,000 per acre and fed 2-3 times per day using a 40-48% protein salmonid diet with 8-10% fat. Feed the fish all they will readily consume at each feeding. Largemouth will feed voraciously on some days and not so actively on others, this is probably associated with temperature, sunlight, and/or water quality changes. A floating diet is desirable as it allows the person feeding to more easily observe the fish feed to satiation . Bass should attain sizes of 6-8 inches (with some larger individuals) by the following fall. This size is well suited for pond stocking and brings approximately $0.75 per fish wholesale and $1.50 per fish retail.

To produce fish of greater than or equal to 1 pound will require at least one additional year of growth. Fish can be thinned to grow-out densities either in the fall or spring, however fish should not be handled when water temperatures are below 55°F due to fungal infections. Some papers have recommended a grow-out density of 2,000 per acre. However, research at KSU found no difference in average weights of fish stocked at 5,000 or 2,500 per acre, while the higher density produced double the amount

of fish per unit of pond. Additional research at KSU found production was best in bass stocked at 5,000-6,000 per acre and fed a 46-48% protein diet with 6-8% lipid. Fish were fed once daily to satiation and produced approximately 4,500 pounds per acre of fish which averaged just under (9/10's) a pound. Bass can be harvested by seine similar to catfish. They are actually easier to catch, but will jump over the seine if edges aren't held high.

Water quality tolerances in largemouth bass vary with age and other culture conditions. Data indicate that feed conversion efficiencies are reduced at oxygen concentrations below 4 milligram per l, avoid D.O. levels less than 3 milligram per liter and can tolerate a D.O. of 1.4 milligram per liter at 25°C. Ammonia tolerance is similar to or slightly less than channel catfish with a 24 hour un-ionized ammonia LC_{50} value of 1.69 milligram per liter. However, centrarchids appear to be very tolerant of high nitrite concentrations due to an ability to prevent absorption. The 96 hour LC_{50} for nitrite is 24.8 milligram per liter in channel catfish but 460 milligram per liter in largemouth bass.

Nutritional research on largemouth bass is extremely limited. In the 1960s Snow at Auburn successfully used the Oregon Moist Pellet, formulated for salmonids, to juvenile bass to a size of about 8 inches. In the 1980s requirement studies determined a protein requirement of 41% for age-one fish. Pond studies raising second year fish to approximately 3/4 of a pound demonstrated that diets containing 42-48% protein could be advantageous. Most largemouth bass in commercial production are currently fed high protein (greater than 40%) salmonid diets based primarily on ready availability. However, reported problems concerning pale, fatty livers and mortality have been thought to be nutritionally related. Liver problems may reflect a skewed protein/energy ratio or excess carbohydrates in the diet. Winter mortality in pellet fed fish has also been reported and could be related to nutrition, especially vitamin deficiencies. Additional nutritional research is sorely needed as an essential component to the development of the efficient aquaculture production of this fish.

Largemouth are susceptible to many of the parasites and bacterial disease common to most cultured fishes. Diseases specific to the largemouth bass are not common although there are recent reports of a largemouth bass virus. The best advice to avoid disease problems is to minimize handling during the summer and winter. Like other centrarchids, especially crappies, largemouth are very susceptible to columnaris (saddleback) disease, especially during the training period. Juvenile bass are especially prone to fungal infections (*Saprolegneosis*) when handled at temperatures less than 55°F and mortality can be extremely high.

Asian consumers appear to desire live largemouth bass above all other freshwater fish. They desire fish of 1.5-2.0 pounds which may require third year grow. A study at KSU showed relatively slow third year growth as fish only went from 0.9 pound to 1.2 pounds during the third summer. Interestingly though, fish grew better at high densities. Production methods for sizes greater than 1.0 pound should be investigated further, as demand for fish of this size has been identified in excess of 700,000 pounds per year at over $3.00 per pound live weight.

Processing of largemouth has not been reported. However, the basses tend to have a relatively round body profile, and may become quite thick in body confirmation at large sizes. Preliminary data from KSU indicated dress-out values similar to catfish (60% whole dress, 40% filet), relatively high protein levels, and extremely high levels of omega-3 fatty acids. These are the "heart healthy" fatty acids reported

to be so advantageous for human health.

(See appendix for recommended publications on Largemouth Bass)

Largemouth Bass

Gross Revenue

	Yield		Selling Price		**Gross Revenue**	*Your Farm*
	3500	pounds	$3.00	lb	**$10,500**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	5000	fingerlings	$0.50	$2,500		
Feed	3	ton	$650.00	$1,950		
Hired labor	40	hours	$8.00	$320		
Electricity				$375		
Marketing charge	3500	pounds	$0.10	$350		
Total Variable Costs					**$5,495**	
Interest on Variable Cost		1 year @ 10%			**$550**	
Return Over Variable Costs					**$4,456**	

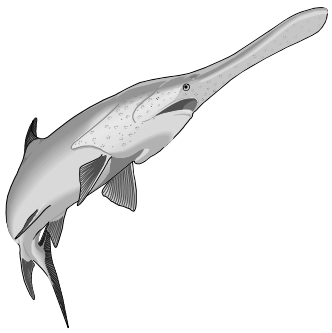
Fixed Costs	**Total Per Acre**	**Annualized**	
Levee construction	$2,500	$166.67	
Well construction	$500	$33.33	
Piping	$150	$10.00	
Bulk feed storage	$200	$13.33	
Aeration	$200	$20.00	
Feeders	$100	$10.00	
Pickup Truck (1/2)	$200	$20.00	
Total Fixed Costs			**$273**
Return to Land, Capital & Management			**$4,182**
Operator Labor	50 hours	$8.00	$400
Return to Land & Capital			**$3,782**

Notes:

Based on per acre production comparable to a 4 5-acre pond catfish production system
Yields range between 4,000-4,500 lbs/acre under experimental conditions
Price is based on live-weight sales. Higher prices may be available selling to sportfish ponds
Higher prices of $3.25-$4.25 have been quoted for live weight
Stocking costs can be reduced to $0.25/fish if purchased in large volume

Production Cost References

Stone, Nathan, Small Scale Catfish Production: Introduction, U Arkansas CES FactSheet, 1994
Stone, Nathan, Carole Engle, and Robert Rhode, Costs of Small-Scale Catfish Production, U Arkansas CES FactSheet, 1997
Pond construction costs reflect helpful input from Mr. Norm Penner
Stocking and yield estimates conservatively reflect those observed at the KY State U Aquaculture Res Ctr



Paddlefish

Paddlefish, spoonfish, spoonbill cat, and *Polyodon spathula* are among several names given to this unique prehistoric fish. The paddlefish is the largest (over 200 pounds, 6-foot long) freshwater fish in the United States and is found in 26 states that have large streams, rivers, and impoundments within the Mississippi River basin and adjacent Gulf Coastal drainages. Paddlefish are highly valued for its black eggs (roe) processed into caviar and its boneless, firm, white meat. However, they are currently available only from the wild populations. Overexploitation and contamination by organochlorine pollutants (i.e. PCB) have required that many state agencies close down this valuable fishery. Commercial paddlefish farming is necessary to meet the market demand for its caviar and meat and alleviate harvest pressure from the wild paddlefish fishery.

Paddlefish have many outstanding characteristics for aquacultural development as a food fish in Kentucky and other states of the United States. Paddlefish filter feed on zooplankton throughout life, are long-lived (greater than 20 years), and grow rapidly (up to 10 pounds per year) reaching sizes up to 200 pounds. They can be harvested by selective gill nets or by seining. Paddlefish can be propagated artificially and fingerlings raised intensively up to 14 inches in ponds, then grown for meat and roe intensively in ponds with catfish or extensively in reservoirs. Paddlefish meat is firm and boneless with a beef or pork-like texture, and it is also similar to sturgeon in taste and texture.

Artificial Propagation

Currently, broodstock are obtained from wild sources. Typically, males are smaller (by one-third to one-half in weight) than females, and have tubercles on their head and opercular flaps that feel like sandpaper. In contrast, mature females have few, to no tubercles, and the abdomen is round and extended during the pre-spawning period.

Broodstock must be held in circular tanks (8 foot) in the hatchery. Water temperature of 60 to 65°F, flow rate of 2 gallon per minute and water saturated with oxygen are optimal conditions. Broodstock should be injected intraperitoneally with hormones to induce spawning. For milt collection, tubing attached to a syringe is inserted into the urogenital pore and collected from the fish. Large volumes of milt can be obtained from one male. Milt from two to three males should be used to fertilize the eggs so as to increase genetic diversity. Milt is checked microscopically and 75-100% of the spermatozoa should be motile.

Milt can be collected several hours before use and stored in sealed containers on wet ice.

For collection of eggs, any one of several methods can be used: hand-stripping, caesarian section, or the Minimally Invasive Surgical Technique, MIST. Hand-stripping is labor intensive and often requires three individuals 8-10 hours at about 30-minute intervals to remove the total volume of eggs. Caesarian section is a relatively quick surgical method (30 minutes) to remove eggs through a 3-4 in abdominal incision; however, suturing is time consuming and muscular stress on the incision usually results in poor retention and less than 25% survival of broodstock. The MIST is minimally invasive and permits quick removal of ovulated eggs and requires much less handling time than the other methods. This method of egg removal involves a small incision in the dorsal area of the oviduct which permits direct stripping of eggs (10 minute) from the body cavity through the gonopore, and bypasses the oviductal funnels. Greater than 90% survival of broodstock is expected.

The eggs should be fertilized using the "wet method". Milt is added to water at a 1:200 ratio (milt to water) and then immediately poured onto the eggs. The fertilized eggs are stirred for one minute then coated with Fuller's earth suspension for 20 minutes. The eggs are then rinsed free of Fuller's earth, volumetrically measured and loaded into McDonald jars at about 70,000 eggs per 2-gallon incubator. Larvae hatch in approximately 6 days when eggs are incubated at 65° F. Larvae must be held for another 5 to 6 days before they will consume food.

Nursery Phase

Larvae can be grown in fertilized earthen ponds or in tanks. In ponds, live food such (*Daphnia spp.*) must be present in order for the paddlefish larvae to have appropriate food until they are large enough to accept extruded pellets. In tank culture, paddlefish larvae can be trained to feed only on prepared diets (i.e. RangenR Trout/Salmon diets).

For pond culture, site preparation should begin about two weeks before spawning. Ponds should be drained and dried. After fish have been spawned, the pond should be flooded with well water or from filtered reservoir water. Rice bran is recommended as the organic fertilizer for paddlefish nursery ponds to promote zooplankton i.e. (*Daphnia*). Once the fish reach about 3.5 inches, they can be trained to eat a 1/16-inch extruded pellet (45% protein). Survival rates can range from about 50 to 80%. It takes approximately 6 weeks for the paddlefish to reach about 5 inches at which time they are able to filter feed. If fish are trained on a prepared diet, they can remain in the ponds and will continue to grow up to 0.5 pounds and 14 inches in about six months.

Production systems

Reservoir ranching and polyculture with catfish are two practical systems to raise paddlefish for caviar and meat. Production of paddlefish in these systems relies on the filter-feeding of naturally produced food organisms; therefore requiring no feed cost and little management. Reservoir ranching is an extensive method for producing paddlefish. Fish are stocked at low densities (10-20 fish per acre) and can reach 10 pounds per fish in about 18 months and can be sold for their meat or permitted to grow until maturity, and then harvested for their roe. Fish are captured with gill nets with nearly 90% efficiency. Survival of greater than 50% is expected in reservoirs. Use of all-female paddlefish for caviar production would be most

beneficial in this system.

Polyculture of paddlefish with catfish is a more intensive system than reservoir ranching. Paddlefish stocked at 30-80 fish per acre with catfish stocked at 4, 000 per acre can reach up to 7-10 pounds in about 12 months with survival of greater than 90%. Fish can be harvested by seining and easily sorted by hand from the catfish. This system is best for paddlefish meat production or for grow-out of paddlefish fingerling for ranching. Further investigation of polyculture with catfish is being conducted through a grant funded by Southern region SARE Program 1999-2001.

Currently there are no commercial sources of paddlefish fingerlings available for fish farmers wanting to try paddlefish. Because of the demand for fish farmers wanting to try paddlefish products, both in-state and out-of-state, and the limited supply of wild caught fish, KSU Aquaculture Research Center applied for and received a KDA Value-added Grant to produce paddlefish fingerlings and to teach interested Kentucky fish farmers how to hatch and raise paddlefish fingerlings.

Food Science/Marketing

Paddlefish meat is firm and boneless and is very similar to sturgeon in taste and texture. We have shown that paddlefish meat is well accepted by consumers. Even those who do not eat fish regularly liked paddlefish products. Recently, we have a developed several smoked paddlefish meat products. Several of the products have been well received in white tablecloth restaurants, gourmet shops, as well as, currently being test marketed in a large food chain in Kentucky. Paddlefish meat also has been tested for surimi (imitation crab meat) production with promising results. Further development of value-added paddlefish products is being studied.

Research at the Aquaculture Research Center, KSU, Frankfort has focused on the development of all-female stock (via genetic manipulation) for the caviar industry, commercial production (reservoir ranching and polyculture) for its meat, food science research for value-added products, and marketing. Most of this information is available for (potential) fish farmers to consider raising paddlefish as an alternative food fish; this is essential to the growth of Kentucky aquaculture.

Russia and other states of the former Soviet Union were the main sources of caviar and sturgeon fish products. The collapse of the Soviet economy has severely impacted the supply of caviar and sturgeon from the Caspian Sea. Paddlefish meat and caviar are similar to sturgeon and have demonstrated a following in the marketplace. Because of this, there is interest in Kentucky paddlefish from caviar and value-added fish products wholesalers. The largest caviar in the U.S. has made several trips to Kentucky investigating the potential to purchase and process paddlefish meat and roe. If a volume supply of paddlefish could be produced in Kentucky, the wholesaler has stated they would be willing to establish a processing facility in Kentucky for paddlefish and other Kentucky fish. Because paddlefish can be grown out in large bodies of water with no feed costs, the Aquaculture Task Force recommends the possibility of using specified public bodies of water to reservoir ranch paddlefish. Reservoir ranching of paddlefish could potentially generate significant aquaculture income and create needed processing facilities within the commonwealth.

(See appendix for recommended publications on Paddlefish)

Paddlefish - Polyculture Supplement to Catfish

Gross Revenue

	Yield		Selling Price		**Gross Revenue**	*Your Farm*
	200	pounds	$5.50	lb	**$1,100**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	50	fingerlings	$2.00	$100		
Feed	n/a	50# bags	$14.50	$0		
Hired labor	1	hours	$8.00	$8		
Marketing Charge				$66		
Total Variable Costs					**$174**	
Interest on Variable Cost	12 months @ 10%				**$17**	
Return Over Variable Costs					**$909**	

Fixed Costs	**Total Per Acre**	**Annualized**		
3% of catfish enterprise	$350	$35		
Total Fixed Costs			**$35**	
Return to Land, Capital & Management			**$874**	
Operator Labor	1 hours	$8	$8	
Return to Land & Capital			**$866**	

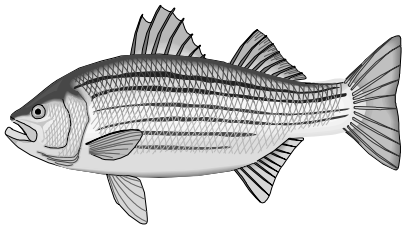
Notes:

Based on per acre production

Assumes growing out paddlefish in an operating catfish enterprise

May see some higher costs assocaited with higher aeration

Additional value-adding opportunities exist with the paddlefish, including processing for fillets, smoking, delivery, etc. While higher revenues may be realized, they also will involve higher production and marketing costs.



Hybrid Striped Bass

Hybrid striped bass (HSTB) are produced by crossing striped bass (*Morone saxatilis*) with white bass (*M. chrysops*). There are two crosses produced: the original cross (also called palmetto bass) is made by using female striped bass and male white bass; the reciprocal cross (also called sunshine bass) is made when female white bass and male striped bass are used. Hybrid striped bass require warm water temperatures (68-86°F) for rapid growth and thus, many pond-based farms have been located in the southern United States. In 1992, approximately 60% of all HSTB production occurred in this region. However, HSTB can be farmed in a wide variety of culture systems, including earthen ponds, raceways, cages, and large cylindrical tanks. In pond systems, ground and surface waters are used and the ambient temperatures control the fish's health and growth rate. In tank or raceway culture systems, heated water can be utilized and recirculated. These recirculating systems are usually indoors and can be developed in areas where pond culture may not be feasible or where natural water temperatures may be too cold to allow for optimal growth rates. Massachusetts, for example, is a leading producer of HSTB, almost exclusively through the use of recirculating systems.

Hybrid striped bass culture can be divided into four phases of production: Phase I culture, the hatchery phase, where the hatched fry are grown for 30-60 days to reach a 1-3 inches fingerling, Phase II culture where phase I fish are grown for between 5 to 9 months to grow to 3 to 10 inch fingerlings, and Phase III culture which is basically a grow-out of fish to market-size (1.5-2.5 pounds) or to adult fish.

For Phase I culture, there are many variables that need to be taken into consideration when growing hatched fry (larvae) to a small fingerling such as pond preparation, water quality management, and handling of fry. All these will differ based on method of production, desired intensity of production, and edaphic conditions of site. In general, 5 to 10 day old fry (post-hatch) are stocked into ponds at rates of 50,000 to 60,000 fry per acre. However, many facilities growing fish for stock enhancement will stock up to 250,000 fry per acre. For commercial food-fish production, a lower stocking rate will allow for more rapid growth. Survival of fry-to-fingerlings can be low (less than 20%), however, values between 25-60% are typical. Fry should be stocked into ponds at night to minimize stress and when water temperatures are 66°F. Oxygen level of the pond should be recorded twice daily (a.m. and p.m.) and ammonia, nitrite, pH, and alkalinity measured twice per week. The ponds are generally fertilized one to two weeks prior to stocking with inorganic or organic fertilizers to aid in the growth of zooplankton which the fry eat. Fry generally will eat the zooplankton in the pond, but supplemental feeding may allow for increased growth and survival of fry. When fish are about 21 days old, a high-protein salmon starter diet is fed 1 to 3 times per day, 7 days per week, at a rate of between 1-5 pounds per acre per day for the first week, and

increased up to 10-15 pounds per acre per day, thereafter. It is generally recommended not to exceed 30 pounds acre per day.

When Phase I fingerlings are ready to be grown to larger fish, they are harvested from the nursery ponds and stocked into ponds for Phase II production. Stocking density for phase II production ranges from 4,000 to 100,000 fish per acre based on the required target size for the fingerlings. For commercial food-fish production, values of between 10,000 and 15,000 fish per acre should be used. Diet should be a high protein (35-50%) floating diet with a pellet size that will allow for consumption by the fish. Feeding rates can be as high as 20% of body weight (BW) for the first 30 days after stocking, but decreased monthly until harvest so that fish should be fed 3-4% BW at that time. Farmers should not sample fish, if possible, since that can lead to stress of fish and disease. The average culture period for Phase II fingerlings is the shortest 150 days and should reach a size of 40 grams per fish (12 fish per pound) and be 6 inches in length. However, there have been reports that fish can reach a weight of greater than 90 grams (5 fish per pound) in a growing season.

Production of Phase III fish involves the growing of hybrid striped bass to market-size on to adults that can be used as broodstock. Phase II fingerlings to be stocked for grow-out should weigh 100-250 grams (4.5 to 2 fish per pound) and stocking density should be between 2,000-6,000 fish per acre. A floating diet with between 38-40% protein should be fed, and fish should be all they will eat once or twice daily, 7 days per week. A standing crop of HSTB at harvest ranges between 2,000 and 5,000 pounds per acre with average weights of 1-2 pounds, and feed conversions of 1.5-2.3.

The culture of HSTB in intensive recirculating systems can also be accomplished. Aquaria can be used to grow fry (larvae) for approximately 10 days post-hatch at densities of 4,000 fry per gallon. After this period, fry should be transferred to either circular tanks (preferable) or rectangular per square tanks. Biological and mechanical filtration systems must be used when growing HSTB in an indoor facility. Costs for tank production have not been reported, but it is surmised that it is at least $2.30 per pound depending upon numerous variables. This is as opposed to costs of $1.75 per pound for pond production. However, tank culture is a profitable enterprise if the producer has identified the proper market(s). Cage, raceway, and intensive pond production methods can also be used to produce HSTB, each having their own requirements.

(See appendix for recommended publications on Hybrid Striped Bass)

Hybrid Striped Bass

Gross Revenue

	Yield		Selling Price		**Gross Revenue**	*Your Farm*
	3500	pounds	$2.50	lb	**$8,750**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	5000	stockers	$0.30	$1,500		
Feed	3	ton	$650.00	$1,950		
Hired labor	40	hours	$8.00	$320		
Electricity				$375		
Marketing charge	3500	pounds	$0.10	$350		
Total Variable Costs					**$4,495**	
Interest on Variable Cost		1 year @ 10%			**$450**	
Return Over Variable Costs					**$3,806**	

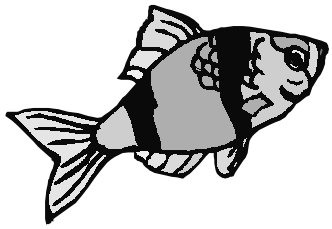
Fixed Costs	**Total Per Acre**	**Annualized**	
Levee construction	$2,500	$166.67	
Well construction	$500	$33.33	
Piping	$150	$10.00	
Bulk feed storage	$200	$13.33	
Aeration	$200	$20.00	
Feeders	$100	$10.00	
Pickup Truck (1/2)	$200	$20.00	
Total Fixed Costs			**$273**
Return to Land, Capital & Management			**$3,532**
Operator Labor	50 hours	$8.00	$400
Return to Land & Capital			**$3,132**

Notes:

Based on per acre production

Yields in a pond system can vary significantly, 2,000-5,000 lbs per acre.

Production and prices are based on targeting fresh product for sale to retail establishments. Higher prices can be obtained in live markets and sales to restaurants, however larger production and marketing costs will be incurred.



Baitfish

Kentucky has several large reservoirs and lakes as well as many smaller lakes, thousands of miles of rivers, and over 135,000 farm ponds. These countless shorelines and waterways offer recreational and sport fishing opportunities for Kentucky residents, and visiting tourists. One thing is certain, when our fishermen sit back and relax to "wet a line," they need to bait their hooks.

Baitfish are usually purchased at local or area bait shops (retailers). Most of the minnows sold in the United States are raised on fish farms in Arkansas and several other southern states. It is estimated that in 1989, Arkansas had 27,800 acres of ponds dedicated to the production of baitfish or minnows, solely. The income generated from these baitfish was estimated at over $25 million. By 1995, Arkansas baitfish production had increased to 28,900 acres with farm gate sales of over $47 million. Today, baitfish aquaculture ranks fourth with more than 60,000 acres of production in the United States. Annual retail sales of baitfish in Canada and the U.S. have been estimated at $1 billion.

The word "baitfish" is a common term used to describe small fish used as bait for sport fishing. Several species of fish are raised as bait: golden shiners (*Notemigonus crysoleucas*), goldfish (*Carassius auratus*), and fathead minnows (*Pimephales promelas*). Golden shiners are the primary species that is farmed for bait (75% of sales in Arkansas). The techniques used to produce the different types of baitfish are similar.

Golden shiner fry for stocking are produced on the farm in broodfish ponds. Mature adults are stocked into broodfish ponds at approximately 400-500 pound of fish per acre. Spawning mats are placed in shallow water around the pond's edge at 100 mats per acre when water temperatures have warmed to 65°F. When the mats have been covered with eggs, they are transferred to fry-rearing ponds (50-100 mats per acre) to allow hatching. After the fry have hatched, the mats are removed from ponds, dried and stored.

Commercially prepared feed is offered to golden shiners in rearing ponds at an initial daily rate of 5 pounds per acre. Feeding rates are increased to 35 pounds per acre by the end of the production season. Pond management includes liming and fertilization, and chemical applications to control diseases if they occur. Water losses due to evaporation are replaced by pumping from wells. Baitfish are harvested by seining the entire pond or by seining a small area of the pond where fish have been congregated for feeding. With good management and carefully controlled daily feeding, minnow harvests of 600 to 800 pounds per acres can be achieved.

Baitfish are transferred from seine nets to tanks mounted on trucks, using buckets and dip nets. Fish are stocked into transport tanks at a rate of 1-2 pounds of fish per gallon of water. The fish are then transported to a holding facility where they are placed in concrete tanks. They are held in these tanks for 24 hours to allow acclimation to crowding in a small volume of water. Baitfish are then graded according to size (number of fish per pound) and delivered to wholesalers or retailers. Small minnows or "crappie bait" contain 125 to 333 fish per pound. Estimating an average yield of 400 pounds per acre and a price of $2.75 per pound, annual returns for a 160-acre farm would be approximately $137 per acre with an annual income of $21,920.

While all of the baitfish species mentioned can be farmed in Kentucky, reliable and consistent markets are the most important consideration for baitfish production in Kentucky. Producers must decide whether they will sell to wholesalers, deliver directly to retailers, or raise, haul, and sell their crop personally. Baitfish sales in the United States are characterized by organized marketing which is structured to prevent entry of newcomers into the industry. These large markets are controlled by large producers who have advanced experience and technology. Also, baitfish producers must be aware of oversupply, shortage, changes in weather patterns that affect sport fishing, and the temporary whims of fishermen concerning "the ideal bait."

Large producers and wholesalers make weekly deliveries to retail baitfish distributors and bait shops surrounding Kentucky's larger lakes and reservoirs. However, it is impractical for them to make return trips to an individual bait shop that is having a busy weekend and who runs short on bait late on a Saturday afternoon. "Topping off" at these bait shops with sudden and heavy, weekend fishing traffic could provide new markets for small, local baitfish producers. Rather than attempting to supply a bait retailer's weekly minnow needs for an entire season, small farmers could replenish or "top off" weekend shortfalls at several area bait shops (i.e., weekend route sales at multiple locations).

The best markets are located near large urban areas and newly established lakes. However, these two conditions rarely occur together. Isolated fishing areas that are difficult for large producers to access provide market opportunities for small, local baitfish farmers. It is possible that a farm with 60 to 70 acres of ponds could provide a baitfish producer with a reasonable income if the farmer could produce 800 pounds per acre of high quality, small baitfish and sell directly to retailers.

Small-scale, niche marketing appears to be the best opportunity for bait producers in Kentucky. Direct retail sales in remote fishing areas could provide additional market openings throughout the commonwealth. Kentucky minnow farmers should start small and expand their acreage as their markets show stable and steady growth. To become a successful Kentucky baitfish producer, you must establish solid markets and provide a high quality product.

(See appendix for recommended publications on Baitfish)